Introducing the Cool, Quiet City Competition: Predicting Smartwatch-Reported Heat and Noise with Digital Twin Metrics

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ABSTRACT

The productivity and satisfaction of humans in the built environment is impacted significantly by their exposure to high temperature and various noise sources. This paper outlines the city-scale collection of 12,009 smartwatch-driven micro-survey responses that were collected alongside 2,825,243 physiological and environmental measurements from 106 people using the open-source Cozie-Apple platform combined with geolocation-driven urban digital twin metrics from the Urbanity Python package. This paper introduces a machine learning competition that will be launched for participants to compete in training models on the various contextual data to predict noise distraction and source as well as thermal preference across a diversity of spaces. The winning solutions of this competition will provide evidence of the types of pre-processing, modeling, and ensembling methods that provide the most accurate solutions for this context.

CCS CONCEPTS

• **Human-centered computing** → *Collaborative and social computing*; • **Computing methodologies** → **Machine learning**;

KEYWORDS

Thermal comfort, Acoustic comfort, Machine learning competition

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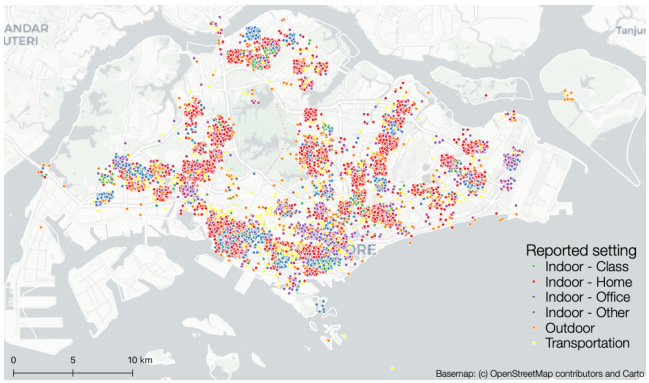

Figure 1: City-scale smartwatch heat and noise-related micro-survey and sensor data

1 INTRODUCTION

People are complex in the aspects of the acoustic and environmental environment that satisfy them. The largest dissatisfaction in indoor office spaces is noise privacy and thermal comfort [2]. Field-based data collection studies to characterize the sources and mitigation of these aspects of the human experience are growing [4]. Large data sets and machine learning competitions have been used in research to address the *generalizability* challenge [3] and the best models for specific applications [1, 6]. This paper describes the launch of the first machine learning competition focused on large-scale self-reported heat and noise data across a city combined with contextual environmental, physiological, and urban-scale digital twin context training data outlined in previous work [5, 7]. Figure 1 gives an overview of the data collected across an urban setting that will form the foundation for crowdsourcing machine learning methods for predicting noise and heat in the urban context.

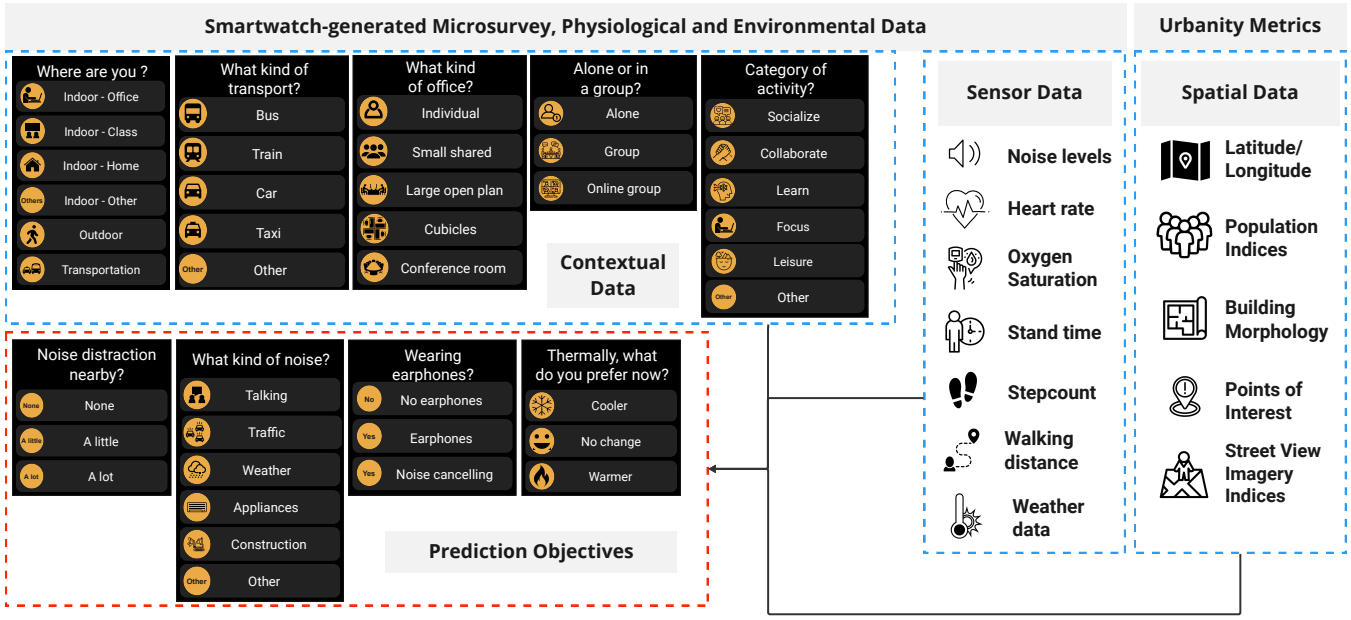

Figure 2: Training/testing data and prediction objectives structure for the Cool, Quiet City Competition

2 THE COOL, QUIET CITY COMPETITION

The data collection process for this competition utilizes the open-source Cozie Apple platform (*https://cozie-apple.app/*) [7]. This mobile and smartwatch application for iOS devices allows people to complete a watch-based micro-survey and provide real-time feedback about environmental conditions via their Apple Watch. It leverages the built-in sensors of the smartwatch to collect physiological (e.g., heart rate, activity), environmental (sound level), and location (latitude and longitude) data. The deployment for this work includes watch survey responses from 106 people, who each provided at least 100 micro-survey responses from October 2022 to August 2023. For each survey response location, digital-twin-created spatial indicators were calculated using the Urbanity python package (*https://github.com/winstonyym/urbanity*) [8].

The Cool, Quiet City Competition, shown in Figure 2, will be hosted as a Kaggle Community competition (*https://www.kaggle.com/competitions/cool-quiet-city-competition*). It will split the previously described data set into training and public and private leaderboard test data segments. The training data will include all variables, while the testing and validation will separate the prediction objectives into a subset that will not be provided to the contestants. The competition participants will use the Kaggle platform to download the training data for model development and then upload the prediction objective variables for the test data sets to receive a classification accuracy metric accuracy score instantly computed to show their rank on a public leaderboard. The contestants can iterate their method and reupload predictions throughout the competition, and the private leaderboard will be calculated at the conclusion, for which the top teams will be invited to release their solutions.

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